R&D Expenditures by Industry Category

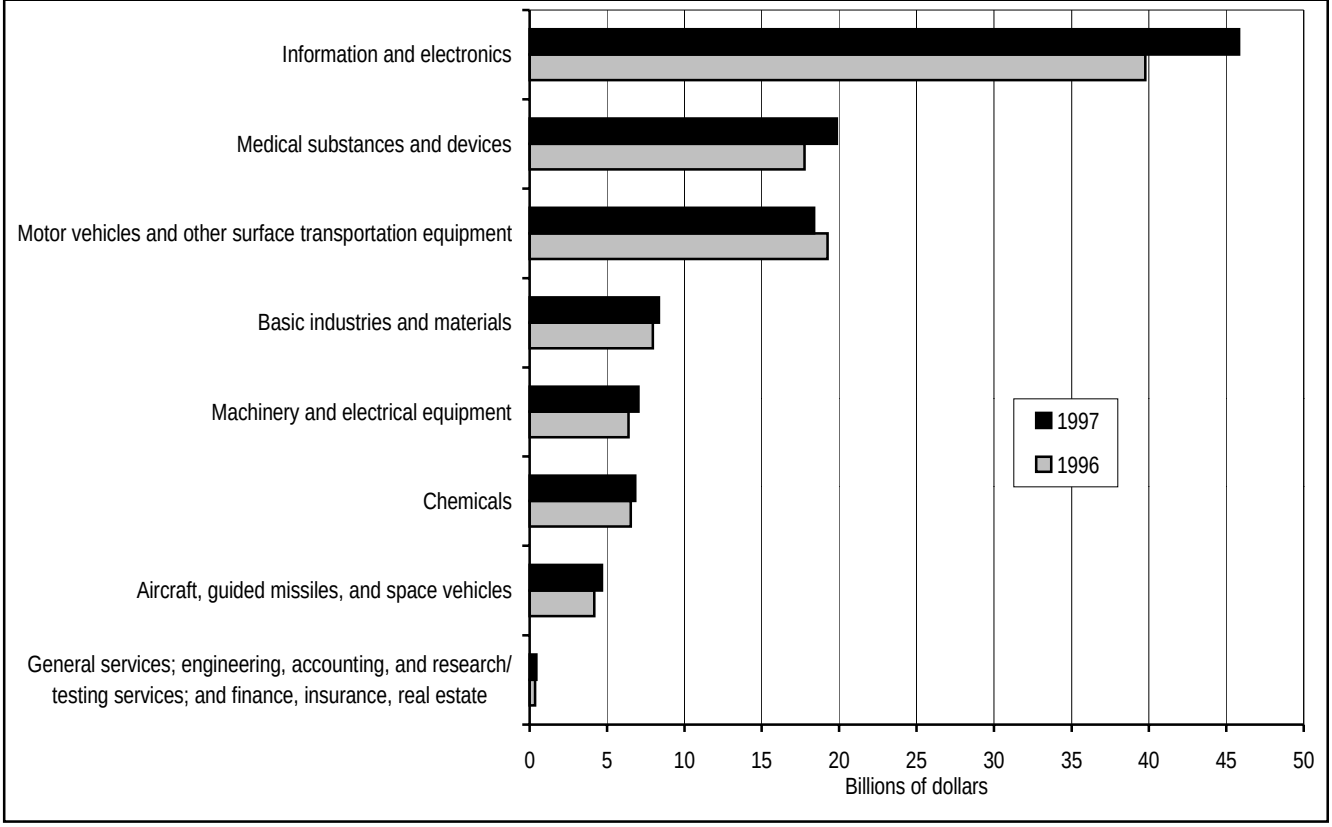
R&D Spending and Growth Rate

Figures 1 and 2, respectively, display the total R&D spending and R&D spending growth rate of the top 500 corporations of 1996 and 1997. These R&D spending levels are grouped among eight major industrial sectors based on their standard industrial classifications and their conceptual similarities with regard to patterns of technological change. These categories are: information and electronics; medical substances and devices; motor vehicles and surface transportation; basic industries and materials; machinery and electrical equipment; chemicals; aircraft, guided missiles, and space vehicles; and all other industries. The all-other category contains only 10 of the top 500 1997 firms in R&D, and less than 0.5 percent of total R&D among those top 500 firms. This category includes general services; engineering, accounting and research/testing services; and finance, insurance, and real estate.[3]

Table 1 (page 21) provides the same aggregate information as figures 1 and 2, along with more detailed information on smaller industrial sectors. It also provides data on employment and sales in 1996 and 1997 in those detailed sectors. These data, however, pertain only to the top 500 corporations in R&D expenditures in each year.

Among the seven major sectors that conducted more than $4 billion in R&D in 1997, the largest R&D sector, information and electronics, increased its annual R&D spending the most, 15.2 percent, to $45.824 billion. The second largest R&D sector, medical substances and devices, raised its R&D spending 11.7 percent to $19.849 billion, moving it ahead of the only declining R&D sector (between 1996 and 1997), motor vehicles and surface transportation, which reduced its spending 4.6 percent to $18.380 billion. The smaller aircraft, guided

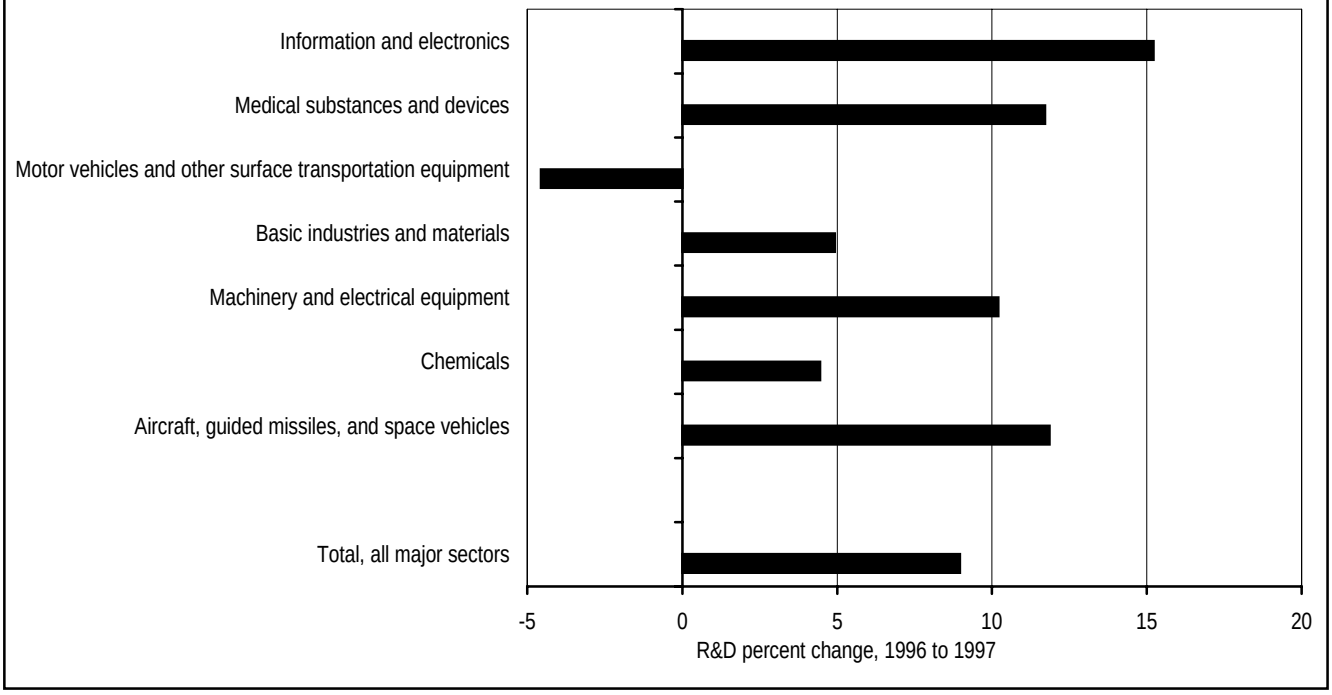
Figure 1. R&D spending by major industrial sectors: top 500 corporations in R&D spending of 1996 and 1997



SOURCE: Standard & Poor's Compustat, Englewood, CO

[3] See tables 1-3 for more information on these sectors.

Figure 2. R&D annual percent change by major industrial sectors: top 500 R&D corporations of 1996 and 1997



NOTE: Totals include all 8 "major industrial sectors", including the sector "general services; engineering, accounting, and research/testing services; and finance, insurance, real estate. This last sector was not shown separately because of its small relative level of R&D.

SOURCE: Standard & Poor's Compustat, Englewood, CO

missiles, and space vehicles R&D sector experienced the second fastest surge in R&D spending, growing 11.9 percent to $4.673 billion.

The R&D spending and R&D growth rates of the two largest major sectors, information and electronics and medical substances and devices, are broken down by detailed industry sector in figure 3**.** Within information and electronics, firms in the electronic computers and computer terminals industry spent the most on R&D in 1997, totaling $11.094 billion, growing 10.1 percent over the previous year. Electronic components, which includes semiconductors, is the second largest R&D spender in the sector at $6.648 billion, growing 17.3 percent, and followed closely by the third largest R&D spender, prepackaged software, which grew 25.7 percent. The impressive 39.2 percent R&D growth rate of the sixth largest R&D spending industry in the sector, computer networking communications equipment, reflects the phenomenal growth of computer network systems, including the Internet.

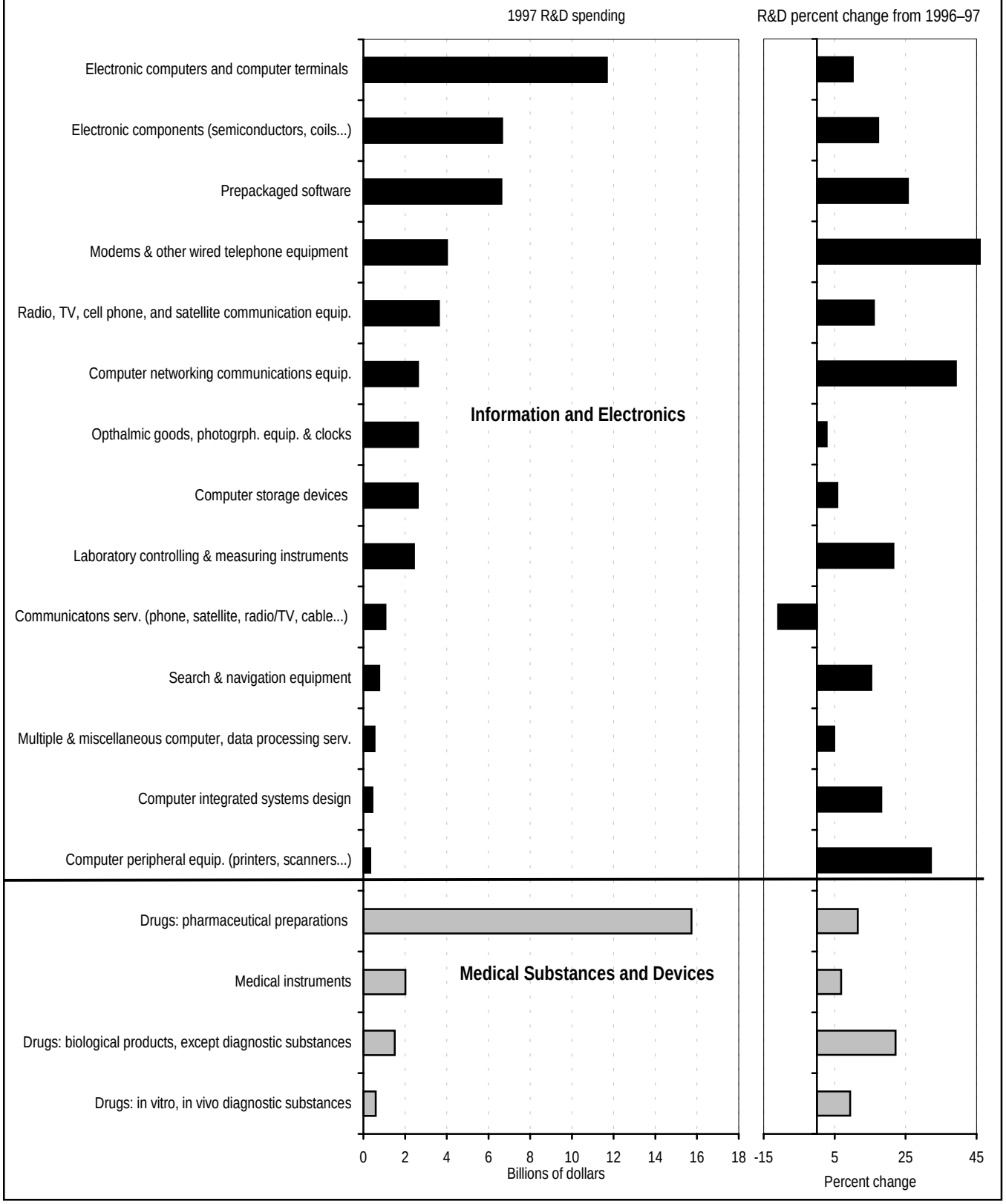
At 46.8 percent, the R&D spending growth of the fourth largest information and electronics industry—modems and other wired telephone equipment—is, in part, misleading because of a one-time shift in the reporting year of Lucent Technologies, Inc. Lucent Technologies accounts for 77.3 percent of that detailed sector's R&D spending. In 1996, Lucent Technologies changed its fiscal year-end from December 31 to September 30, consequently shortening its 1996 reporting year to only 9 months. This led to in a reduction in the reported amounts of R&D spending in 1996 and other indicators to about three-quarters of what they would have been otherwise, thereby resulting in an artificially-inflated, reported growth rate between 1996 and 1997.

Within the medical substances and devices sector, pharmaceuticals preparations firms spent by far the largest amount on R&D, totaling $15.733 billion in 1997, which was up 11.5 percent over 1996. Medical instruments firms spent a total of $2.018 billion, 6.8 percent more than in 1996.

R&D Intensity

Figure 4 shows the combined R&D intensity of firms in each major industry sector. R&D intensity is the ratio of R&D to sales expressed as a percentage. In 1997, medical substances and devices firms had by far the highest combined R&D intensity at 11.8 percent, a

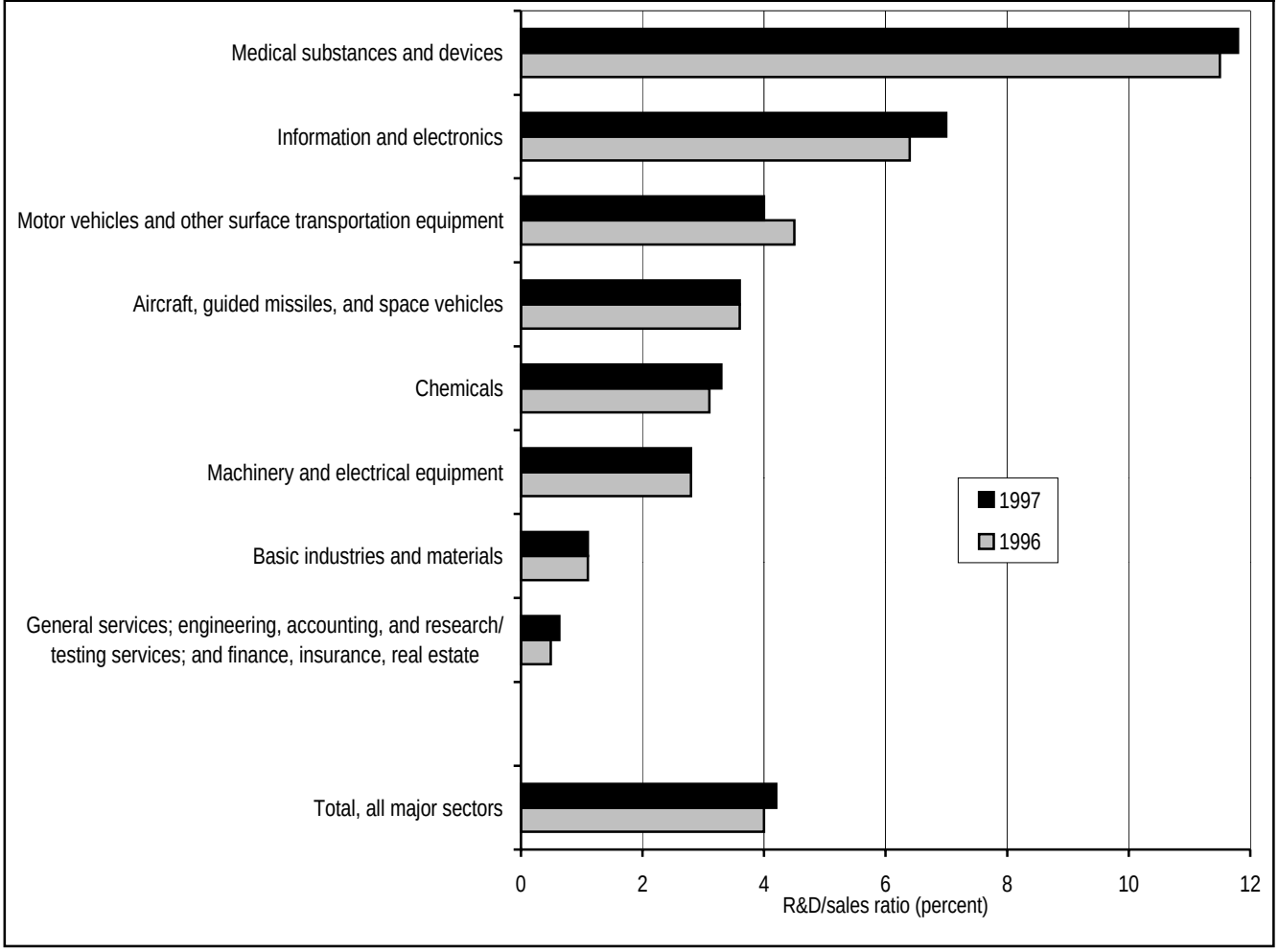
Figure 3. R&D spending and R&D growth of detailed industry sectors within the information and electronics sector and medical substances and devices sector



NOTE: The figure does not include the two smallest *information and electronics* industry sectors: (1) *household audio & video equipment, and audio recordings*, which spent $230 million on R&D with a 73-percent R&D decline from the previous year; and (2) *calculating/accounting machines & office machines,* which spent $210 million on R&D with a 2-percent growth in R&D.

SOURCE: Standard & Poor's Compustat, Englewood, CO

Figure 4. R&D intensity by major industrial sectors: top 500 R&D corporations of 1996 and 1997



SOURCE: Standard & Poor's Compustat, Englewood, CO

0.3-percentage point increase over 1996 and well above the 4.2-percent average for all 500 top 1997 R&D spenders combined. The information and electronics sector ranked second in intensity at 7.0 percent, an increase of 0.6-percentage points over 1996. Both these sectors increased their intensity due to increases in R&D spending rather than reductions in annual net sales.

As indicated in table 2 (page 23), the pattern of R&D spending per employee for the seven sectors is similar to that for R&D intensity with medical substances and devices, again the highest at $29,095 per employee. Information and electronics is second at $16,381.[4] Combined, the top 500 1997 R&D firms spent $10,457 per employee. Table 2 also provides R&D/sales ratios for major and detailed sectors, as well as data on capital expenditure from 1996–97. Like table 1, table 2 is restricted to only the top 500 corporations in R&D expenditure.

While these R&D-to-sales ratios reflect the relative tendencies of companies to devote their own resources to R&D activities, they do not reflect the additional resources provided by the Federal Government (not included in this data series) that increase the actual amount of R&D performed. Such Federal support for R&D varies greatly by industry. Therefore, any study of the broader question of how much total R&D is performed by industry would require supplemental data on Federal support in addition to the data provided in this report.

[4] See table 2 for industry figures on R&D spending per employee.

For example, according to the SRS findings, the Federal Government provided $23.7 billion for industry R&D in 1996.[5] Aerospace companies (or the industrial sector "aircraft and missiles") alone received 44 percent of all Federal R&D funds provided to all industries. Consequently, 65 percent of the aerospace industry's R&D dollars came from Federal sources, while the remaining 35 percent came from companies' own funds. In comparison, the drugs and medicines sector in 1996 financed 100 percent of its R&D from company funds;[6] machinery 99 percent; professional and scientific instruments 68 percent, transportation equipment other than aircraft and missiles 90 percent, business services 97 percent, and engineering and management services 62 percent.

R&D-to-sales ratios are known to reflect differences among industries in their relative reliance on R&D. However, comparisons between industries on this basis should be made cautiously, because, depending on the situation, the R&D-to-sales ratios may be as circumstantial as they are strategic. For example, in the case of the pharmaceutical industry, R&D is performed not only for the sake of discovering new products, but for the sake of product testing to meet regulatory requirements once a new product has been designed. A change in such regulatory requirements might, therefore, change the amount of R&D conducted without changing the number or value of new products being developed. Furthermore, for all industries, the cost of materials to the firm is included in the firm's sales, even though that materials cost reflects the "sales" of another firm earlier in the production chain. As a result, firms further along the production chain will have higher sales, and thus lower reported R&D-to-sales ratios, even though R&D as a proportion of the firm's contribution to GDP (as measured by value added) might not be any lower.

Finally, it is important to note that *U.S. Corporate R&D* does not distinguish between kinds of R&D by character of work (i.e., basic research, applied research, and development). According to other 1997 SRS data, more than two-thirds of U.S. industry R&D spending consists of development. Of the remainder about 22 percent is applied research and less than 7 percent basic research. Significantly, spending on development contributed to almost all the robust growth in industry R&D during the 1990s. Contrarily, basic and applied research experienced substantial declines in the mid-1990s. While both kinds of R&D regained ground in the last half of the decade, by 1997 industry basic research spending had only recovered to 1991 levels in real terms. During the same period, modest growth in Federal spending on basic research (and to a lesser extent academic spending) ensured positive growth in the Nation's overall investment in basic research.[7]

Comparison of R&D Spending to Sales, Employment, and Capital Investment

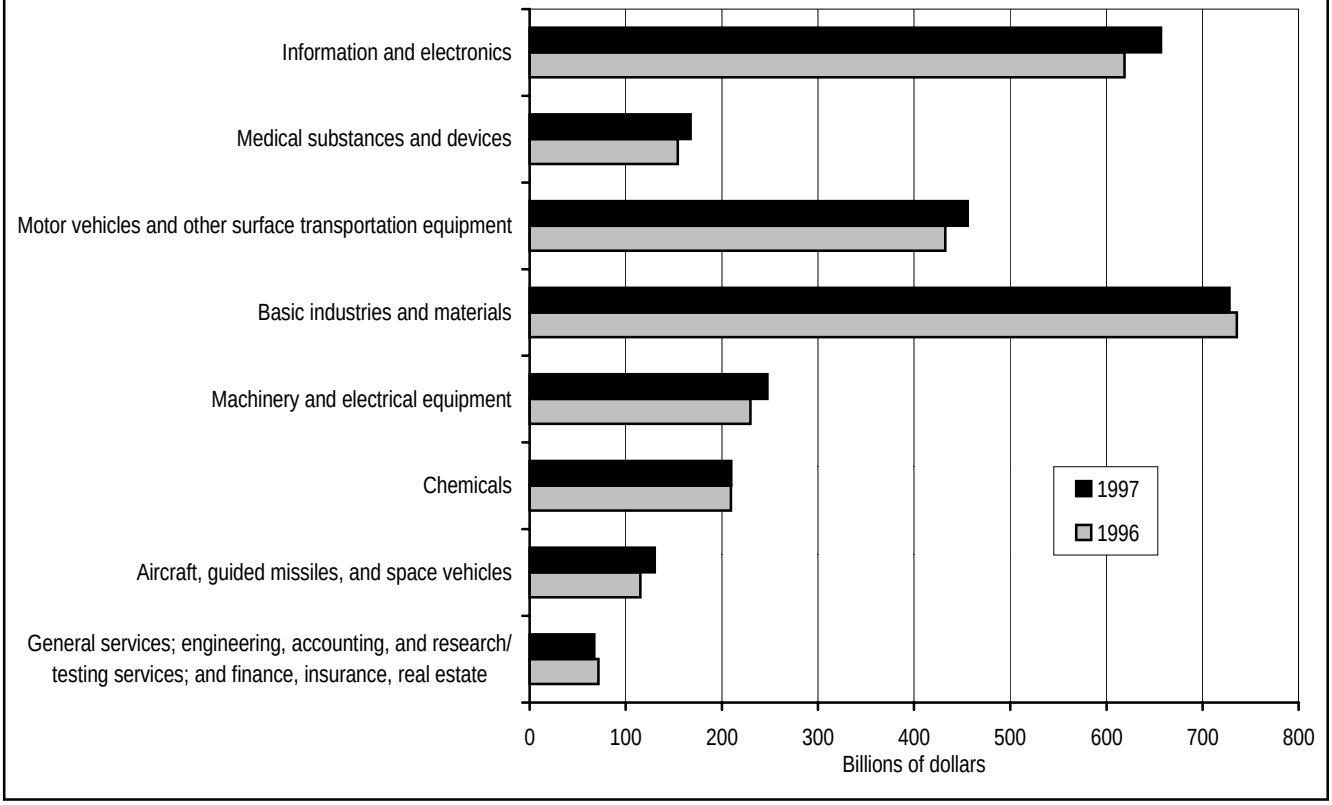
Figures 5, 6, and 7 reflect net sales, employment, and capital spending, respectively, for the major R&D sectors. Figure 8 reflects each sector's percentage share of these three indicators, as well as R&D spending. In 1997, basic industries and materials led information and electronics in sales. But information and electronics employed more workers than other sectors, and edged out motor vehicles and surface transportation and basic industries and materials in capital spending. In considering these data, it is important to bear in mind that R&D, sales, employment, and capital spending totals of these industrial sectors reflect only the activity of the year's top 500 R&D-spending corporations. Consequently, these data understate the aggregate R&D, sales, employment, and capital spending of the sectors examined. That is, sectors that have disproportionately fewer companies in the top 500 will tend to be understated more than other sectors. The most understated sectors in this respect are the basic industries and materials sector and the miscellaneous sector that includes general services, finance, insurance, etc. Nevertheless, for purposes of comparing the R&D-active portions of large corporations in all sectors, the data for these indicators are relevant.

[5] National Science Foundation, *National Patterns of R&D Resources: 1998*, by Steven Payson, NSF 99-335 (Arlington, VA, 1999).

[6] The 100-percent company funding for the drugs and medicines sector does not include support for R&D that NIH ultimately provides to this sector through its own research and through funding of research by universities and other organizations.

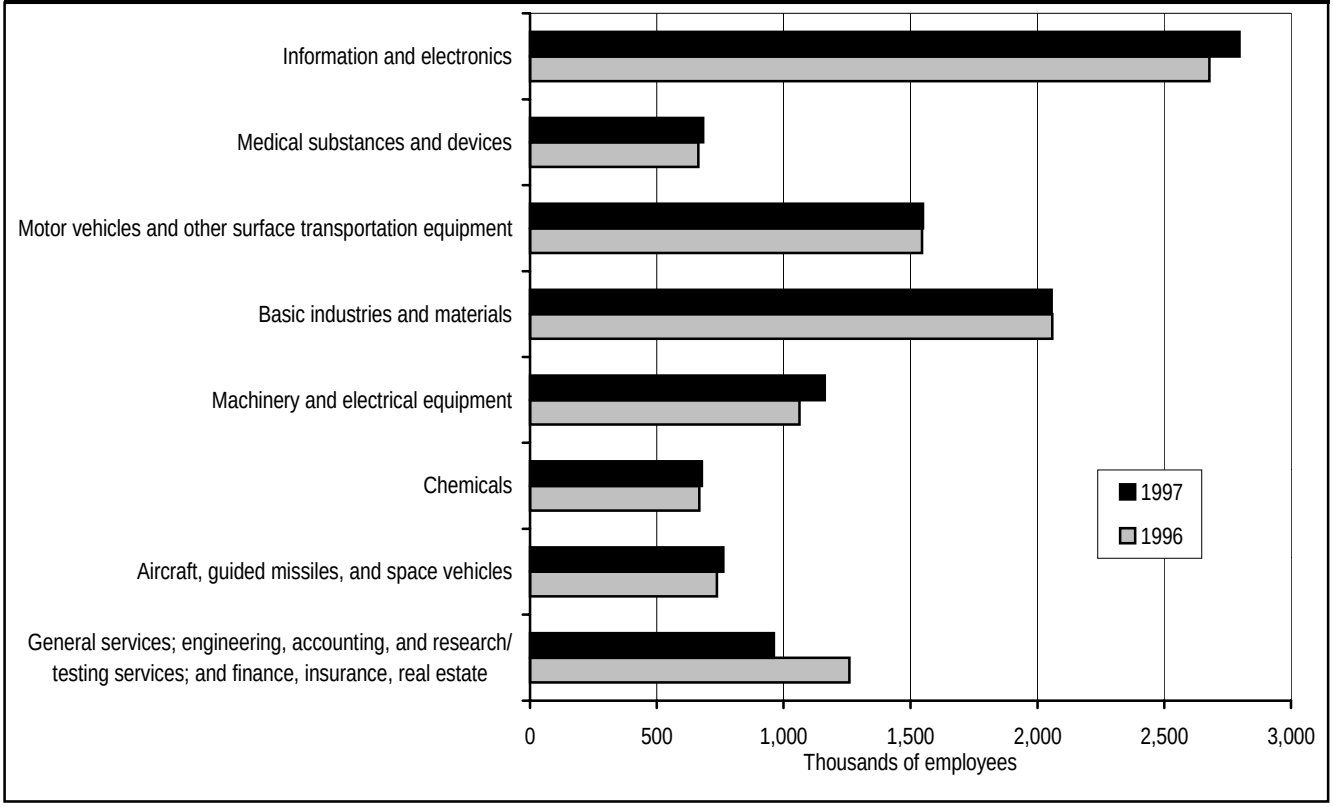
[7] National Science Foundation, *National Patterns of R&D Resources: 1998*, by Steven Payson, NSF 99-335 (Arlington, VA, 1999).

Figure 5. Net sales by major industrial sectors: top 500 R&D corporations of 1996 and 1997



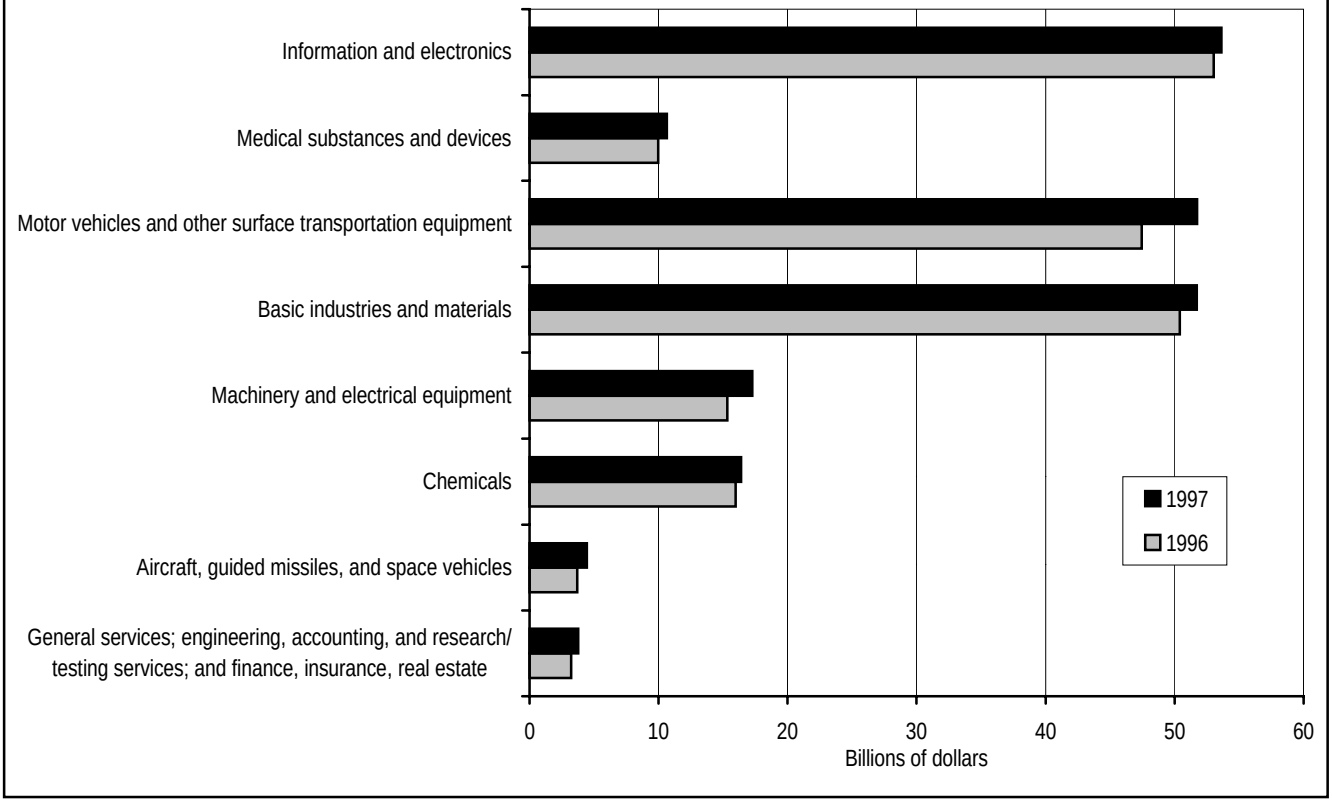
SOURCE: Standard & Poor's Compustat, Englewood, CO

Figure 6. Number of employees by major industrial sectors: top 500 R&D corporations of 1996 and 1997



SOURCE: Standard & Poor's Compustat, Englewood, CO

Figure 7. Capital spending by major industrial sectors: top 500 R&D corporations of 1996 and 1997



SOURCE: Standard & Poor's Compustat, Englewood, CO

For the major R&D sectors, figure 9 compares the 1997 annual percent change in R&D spending to changes in net sales, capital spending, and employees. Total R&D of the seven major sectors grew by 9.0 percent between 1996 and 1997. This growth significantly out paces net sales (3.7 percent), capital investment (5.3 percent), and employment (a decline of 0.2 percent).

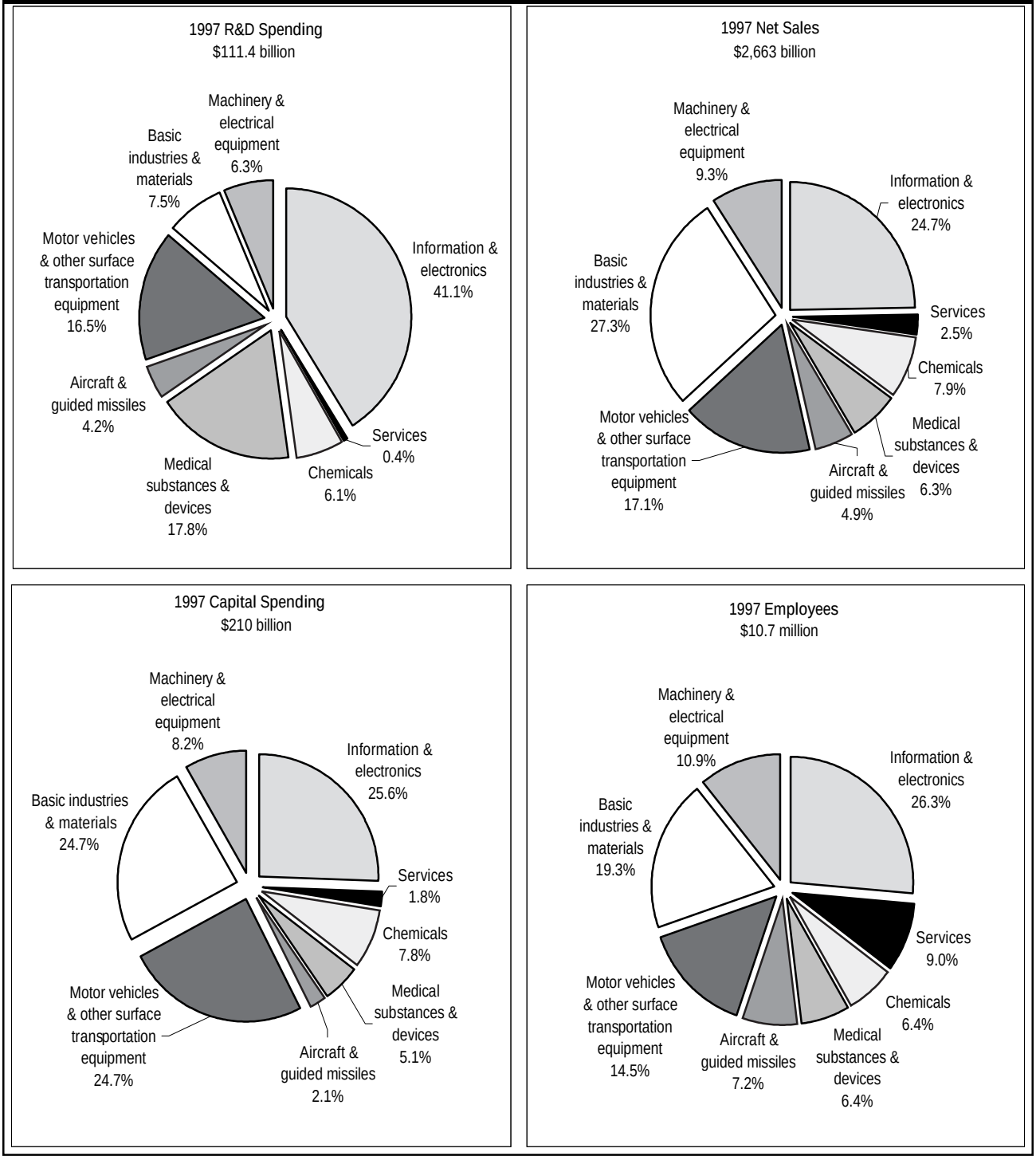
The comparison among the seven major R&D sectors, as shown in figure 9, with respect to the four indicators varies substantially. R&D growth out paces sales growth in five sectors. But it lags well behind sales in motor vehicles and surface transportation, and is slightly behind sales in the aircraft, guided missiles, and space vehicles. Capital spending growth exceeded R&D growth in three sectors: motor vehicles and surface transportation; machinery and electrical equipment; and aircraft, guided missiles, and space vehicles.

In general, high R&D growth sectors experienced stronger employment growth than sectors having slow R&D growth, although again, it is not possible to draw any connection between these variables from this limited data. Machinery and electrical equipment enjoyed the fastest employment growth at 9.4 percent, followed by information and electronics at 4.4 percent and aircraft, guided missiles, and space vehicles at 3.5 percent. The slower growing R&D sectors, motor vehicles and surface transportation, and chemicals, experienced the lowest employment growth of the seven sectors, 0.2 percent and 1.6 percent, respectively.

Comparison of Growth Rates in R&D Spending & Net Sales

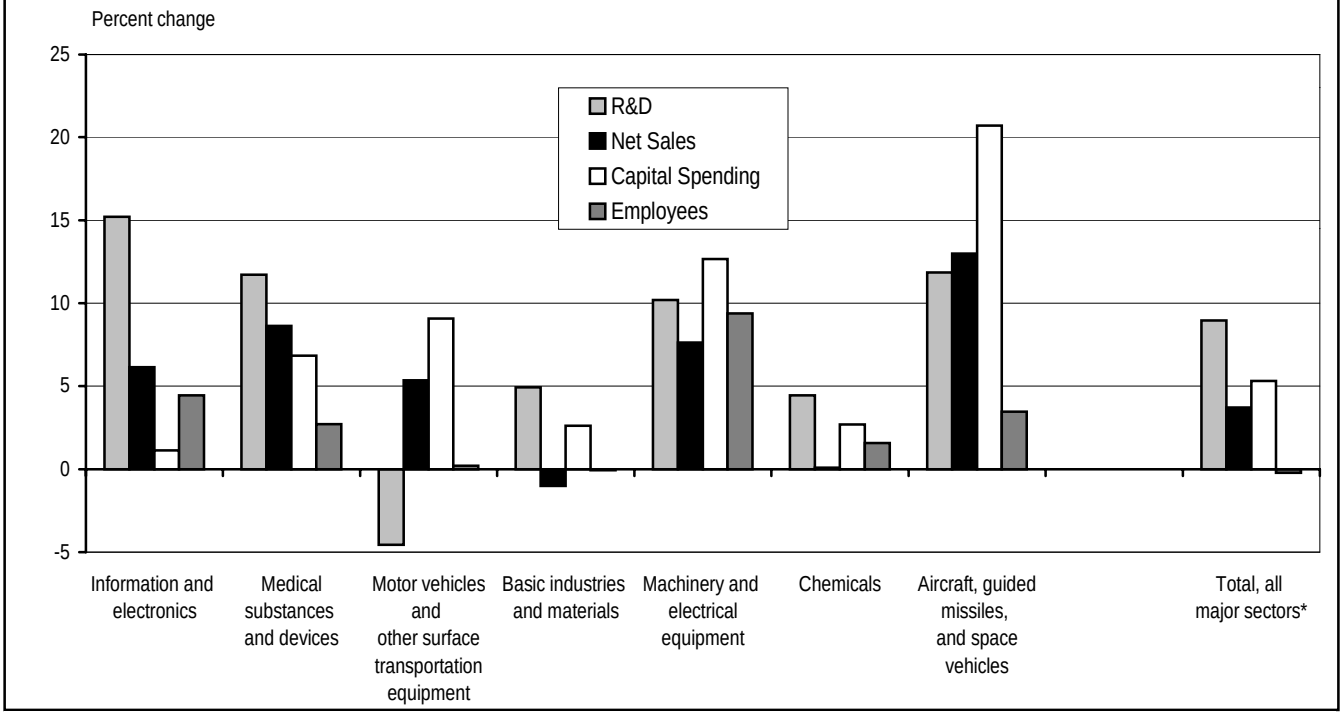
As shown in figure 10**,** which highlights the seven largest R&D sectors, R&D growth roughly correlates with sales growth in 1997. That is, growth in R&D spending tends to be higher for industries that have higher sales growth. Each sphere in figure 10 represents an industry. A close relationship would not be unexpected since the amount of company funds available for R&D investment often depends on the company's sales performance in the current and immediately preceding years. On the other hand, given that investment in R&D is frequently undertaken with the intention of eventually achieving higher sales, R&D investment may be as much a cause of sales growth as it is a result.

Figure 8. Major industrial sector shares of R&D, sales, capital spending, and employment: top 500 corporations in R&D spending for 1997



SOURCE: Standard & Poor's Compustat, Englewood, CO

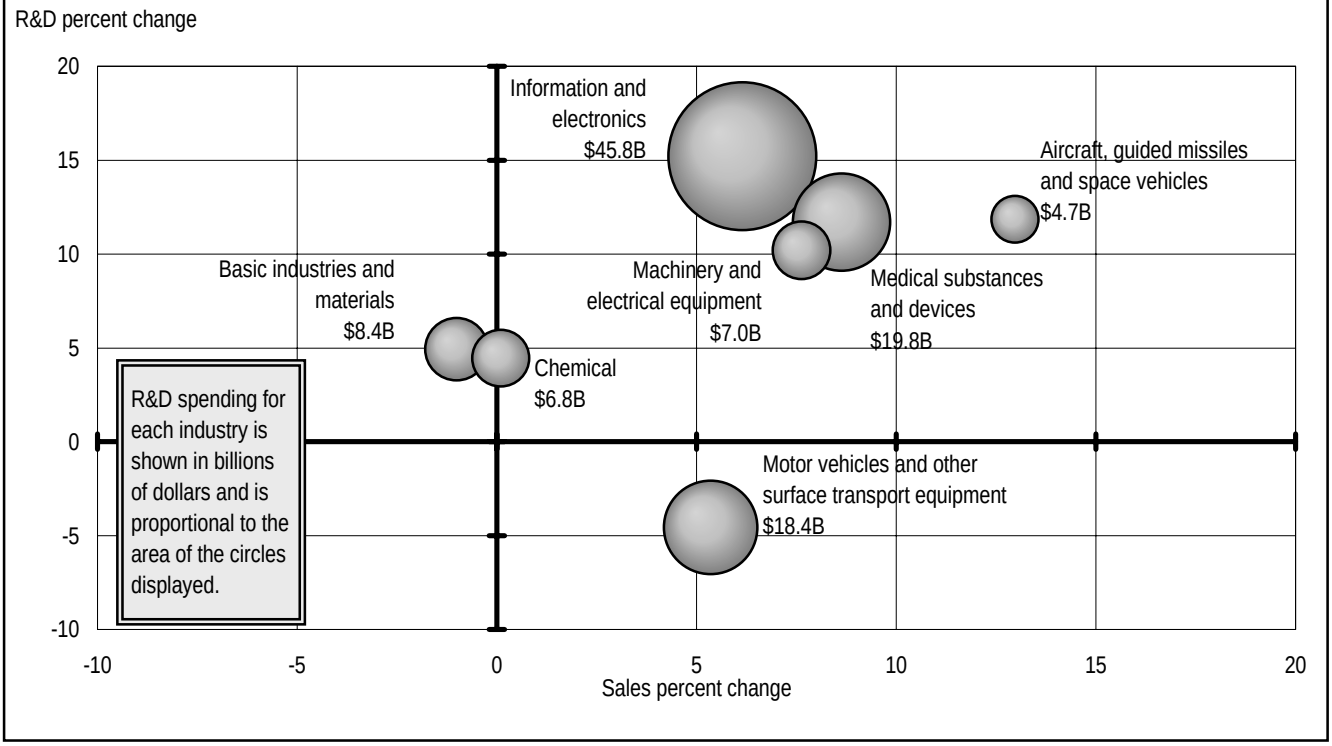
**Figure 9. Percent change between 1996 and 1997 in R&D spending, sales, capital spending, and employees by major industrial sector:
top 500 R&D corporations of 1996 and 1997**



*Totals include all 8 "major industrial sectors", including the sector "general services; engineering, accounting, and research/testing services; and finance, insurance, real estate. This last sector was not shown separately because of its small relative level of R&D.

SOURCE: Standard & Poor's Compustat, Englewood, CO

**Figure 10. Comparison of change in R&D and net sales between 1996 and 1997 and billions of R&D dollars per industry by major industrial sector:
top 500 R&D corporations of 1996 and 1997**



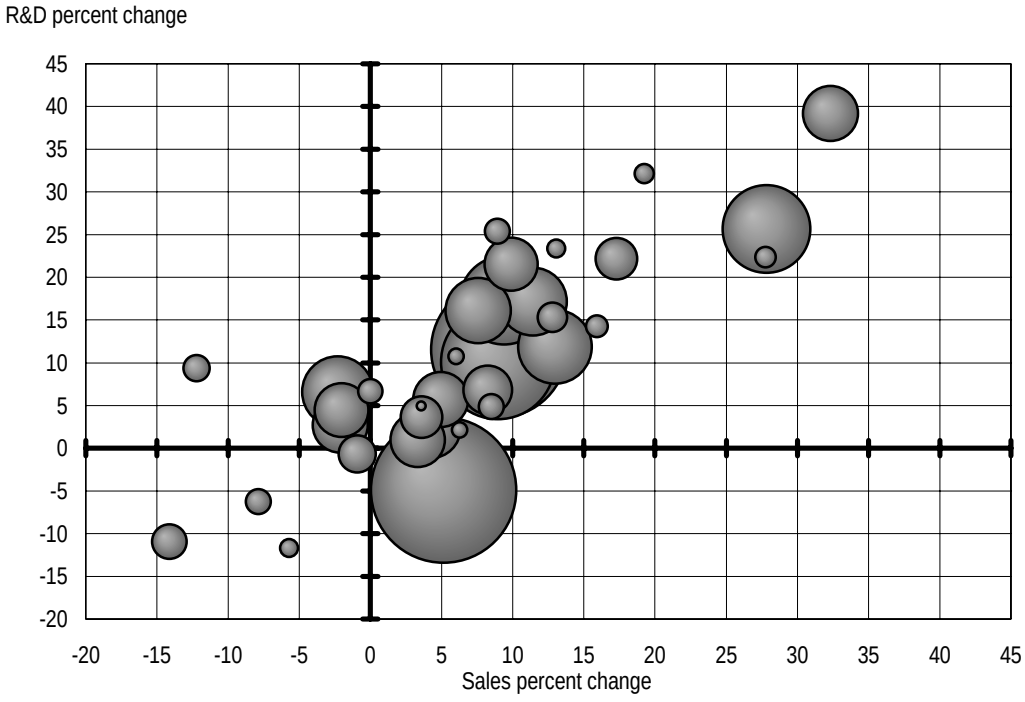
SOURCE: Standard & Poor's Compustat, Englewood, CO

This relationship shows up more clearly in figure 11, which aggregates R&D spending and sales growth data for the top 500 companies of 1996 and 1997 into the 45 detailed sectors. In the figure, the various industries cluster along a diagonal line that runs from the lower left corner to the upper right corner. This clustering, which shows the positive relationship between R&D growth and sales growth, is also borne out by individual firm data for the top 500 firms.

Distribution by Number and Size of Firm

As shown in figures 12 and 13, respectively, the major industry sectors vary in number, as well as average sales of top 500 R&D-spending firms. At one extreme, aircraft, guided missiles, and space vehicles, and motor vehicles and surface transportation, respectively, had 8 and 22 of the top 500 firms in 1997. The average net sales of firms in these two sectors were, respectively, $16.286 billion and $20.720 billion in 1997. At the other extreme, medical substances and devices and information and electronics, respectively, claimed 83 and 217 of the top 500 firms, but the net sales averages for firms in these sectors were relatively small, respectively, $2.020 billion and $3.027 billion in 1997. While these numbers reflect only the 500 largest of the more than 3,400 public firms whose R&D is reported in Compustat, they are significantly different enough to suggest that certain major R&D industry sectors have quite different industrial structures. As a consequence, the competitive conditions that influence firm R&D decisions and spending levels may also vary from one industry to another.

Figure 11. Comparison of change between 1996 and 1997 in detailed industries* R&D and net sales and billions of R&D dollars per detailed industry: top 500 R&D corporations of 1996 and 1997



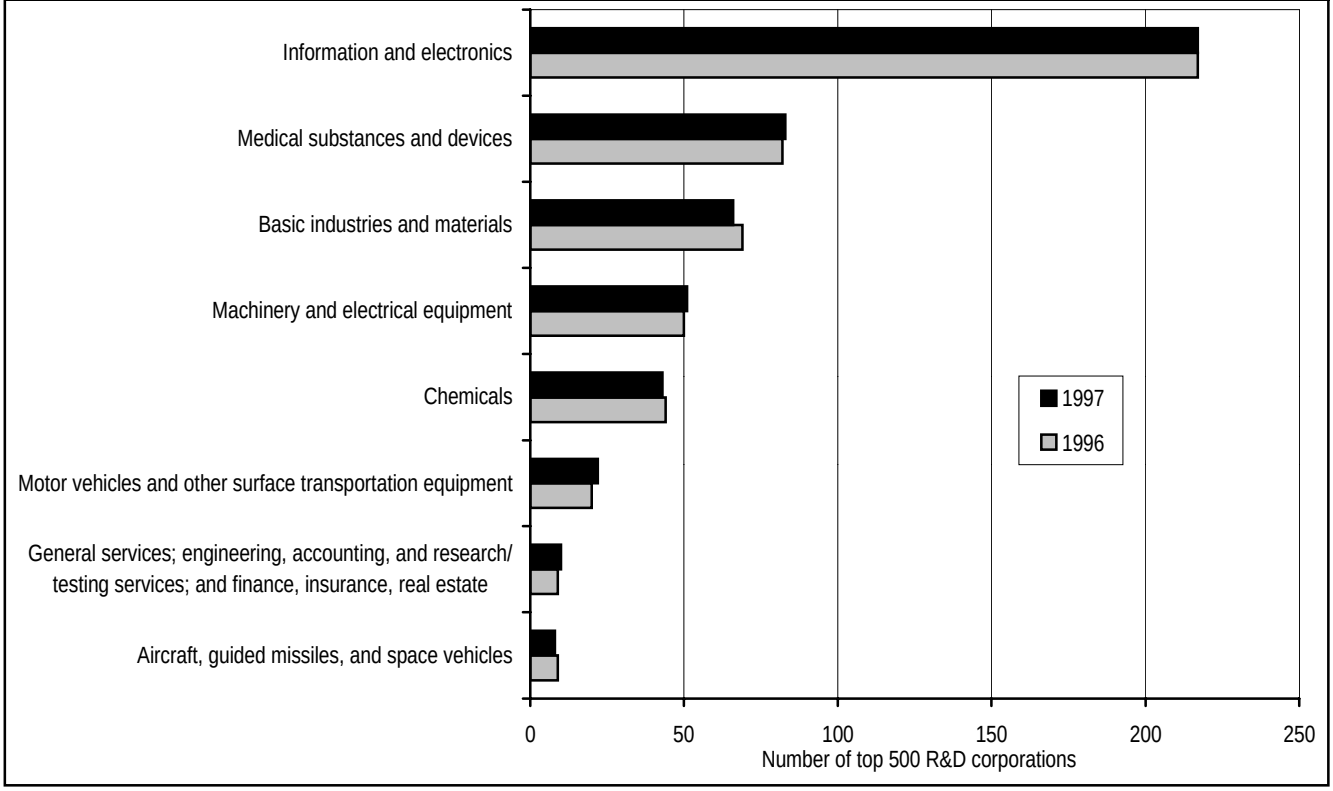
R&D spending for each industry is proportional to the area of the circles displayed. The largest detailed industry, "motor vehicles and motor vehicle equipment," spends the most for R&D, $18.093 billion.

Five industries with R&D percent changes and/or sales percent changes are outside the scales of this chart. They are not shown here in order to preserve the detail of the information displayed. These industries have the following R&D/sales percent changes: –73%/–58%, –34%/–56%, 18%/64%, 47%/41%, and 62%/11%. The R&D spending totals of firms in these industries are respectively: $230, $60, $431, $4,011, and $159 million.

*Except sectors in "engineering, accounting, and research/testing services," "finance insurance, real estate," and "general services."

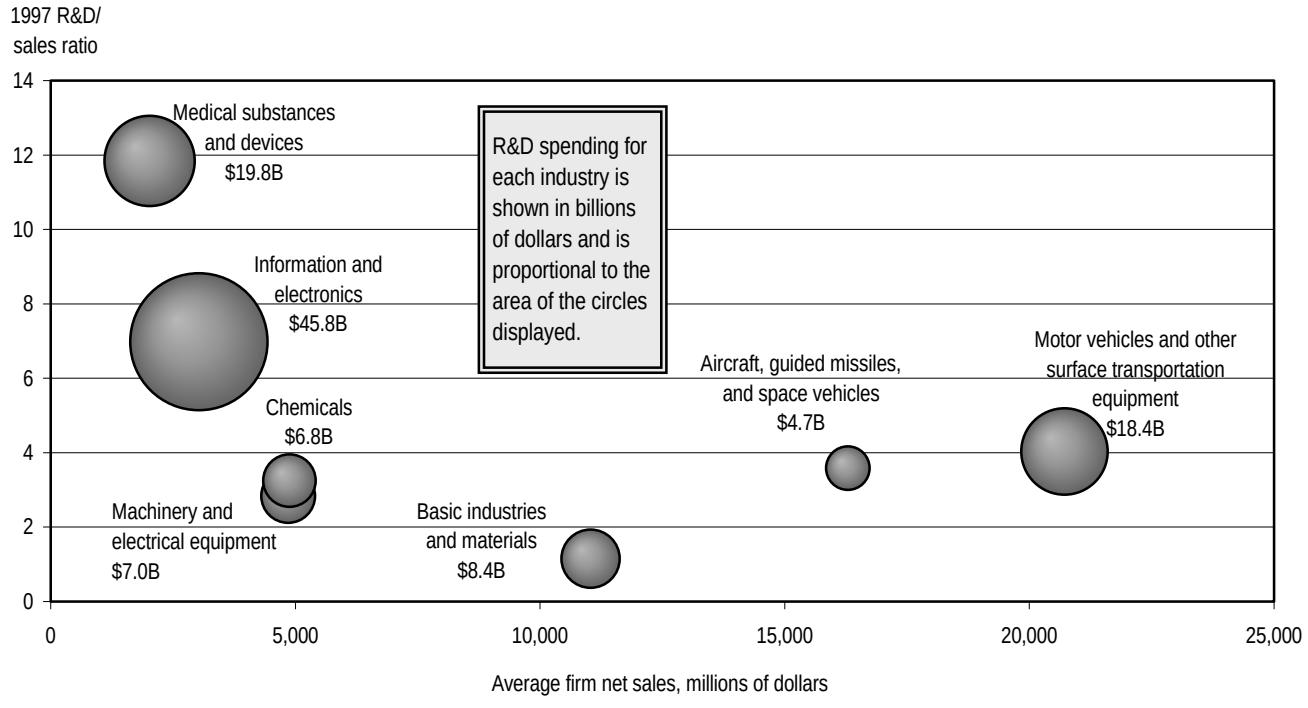
SOURCE: Standard & Poor's Compustat, Englewood, CO

Figure 12. Number of top 500 R&D corporations in major industrial sectors: 1996 and 1997



SOURCE: Standard & Poor's Compustat, Englewood, CO

Figure 13. R&D intensity compared to average firm net sales by major industrial sector
Billions of R&D spending per industry, top 500 R&D corporations of 1997



SOURCE: Standard & Poor's Compustat, Englewood, CO